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On the Egg-guarding Behavior of a Chinese Symphytognathid Spider of the Genus *Patu* Marples, 1951 (Araneae, Araneoidea, Symphytognathidae)

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The eggsacs and egg-guarding behavior of a species of *Patu* from montane forests in the Gaoligongshan of western Yunnan Province, China, mirror that reported by Marples (1951) for *P. samoensis* from Samoa. The eggsacs are deposited as a loose group on the frame near the periphery of the spiral portion of the web.

Symphytognathid spiders are known for their small size and beautiful, finely-woven, horizontal orb webs. Most adults are less than 1mm in total length and, with an adult female at 0.55mm or less, *Anapistula caecula* Baert and Jocqué from West Africa may be the world's smallest spider (Baert and Jocqué 1993). Symphytognathids appear to be common in moist environments in the tropics and south temperate regions but their small size has made them rare in collections. They are most often collected by sieving leaf litter, a technique that reveals little of their life style. *Curimagua bayano* from Panama is unique in being a kleptoparasite in the webs of diplurid spiders, but most other symphytognathids appear to be free-living web-builders (Forster and Platnick 1977). Symphytognathid webs have been described from several continents. The majority of these observations are of horizontal, 2-dimensional orb webs with many accessory radial lines that anastomose before reaching the hub (Forster and Platnick 1977, fig. 1; Coddington 1986, fig. 12.24; Hiramatsu and Shinkai 1993, fig. 1). Most observations are on the webs of various *Patu* species from Samoa (Marples 1951), Fiji (Marples 1951; Forster 1959), Central America (Coddington 1986; Eberhard 1987) and Japan (Hiramatsu and Shinkai 1993). Undescribed *Patu* species from Tanzania, Madagascar and Australia make similar webs (Griswold, unpublished data). A Puerto Rican *Anapistula* makes a similar web (Coddington 1986, fig. 12.23; Griswold et al. 1998, fig. 3c). Hickman (in Forster and Platnick 1977:3) reported that the Tasmanian *Symphytognatha globosa* Hickman, 1931 makes a web of a few irregular horizontal threads. This is unique among symphytognathids, and at least the South African *Symphytognatha imbulunga* Griswold, 1987 makes a horizontal orb typical for the family (Griswold, unpublished).

Eggsacs of Symphytognathidae have previously been reported by Hickman in the original description of the family (Hickman 1931) for captive spiders reared in the lab and by Marples for spiders in the field (Marples 1951). We here report on the eggsacs of a *Patu* species from southwestern China, which resemble those described by Marples for the Samoan *P. samoensis* Marples, 1951 and Fijian *P. vitiensis* Marples, 1951 fifty years previously.

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Study Site

Symphytognathids were observed at 2000m elevation near Qiqi He in the Nujiang State Nature Reserve, Yunnan Province, China. This nature reserve is in the Gaoligongshan (Gaoligong Mountains), which extend north-south along the border between China and Myanmar, dividing the watersheds of the Irrawaddy (Dulong Jiang) and Salween (Nu Jiang) Rivers. Because of its physical isolation and long-standing political instability the area is less disturbed than most other regions in Yunnan. Large tracts of old growth forest with a rich flora of hardwood and coniferous trees persist in the mountains. *Taiwania*, a relictual genus of Taxodiaceae, occurs in this area. Affinities of known spiders are with the Himalayas (Griswold et al. 1999). This area, part of the 'East Himalayan Region,' has been recognized as an area of biotic richness and endemism (Myers 1988).

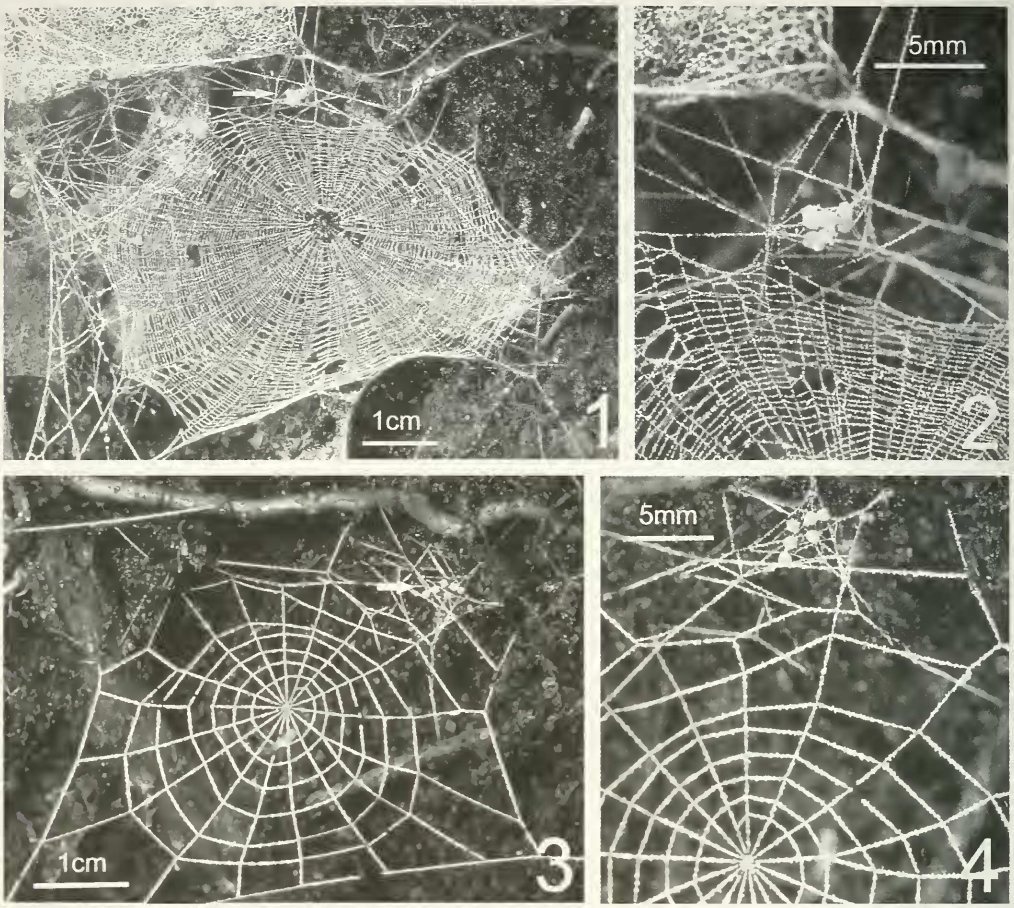
Materials and Methods

Dark, shaded embankments along stream courses and hillsides, the sides of fallen logs, and tree trunks were searched for symphytognathid webs. Because of their fine structure and the dark environment in which they occur, webs were invisible, although those containing eggsacs could be located by noticing these tiny, white objects. Corn starch was broadcast into suitable habitats and clung to small webs, including those of symphytognathids, making them visible. Spiders were collected by visualizing the web with corn starch, locating the spider (in most cases hanging at the hub), placing a spoon beneath the web, and gently tapping the center of the web, causing the spider to drop into the spoon. A description of the method and photos of the site and spiders are available at: *http://www.calacademy.org/research/cnhp/* and *http://www.calacademy.org/science_now/archive/academy_research/griswald_10172000.html*. The locality record is China: Yunnan Province: Nujiang Prefecture: Nujiang State Nature Reserve, Qiqi He, 9.9 air km W of Gongshan, 27°43′N, 98°34′E, 2000m, 9–14 July 2000, C.E. Griswold, H.–M. Yan, and D. Ubick. Close up photos of the eggsacs and female (Figs. 5–6) were taken with a Leica MZ12.5 stereomicroscope and the numerous photos with different focal planes were digitally montaged into one in-focus image using the software package Automontage® made by Syncroscopy. Voucher specimens are deposited in the College of Life Science, Hunan Normal University (CASENT Nos. 9000339, 341, 342, 369, 371 and 9000372) and Department of Entomology, California Academy of Sciences (CASENT Nos. 9000338, 340, 343, 370, 373, and 9000374).

Observations

Sixty adult females, two juveniles and eight adult males were collected during five days of collecting. All individuals were taken from horizontal 2-D orb webs (Figs. 1, 3) that were typical of those previously described for symphytognathids. Although at the time of collecting it was not possible to determine the sex or maturity of the spiders, occasionally two would drop from the center of the same web suggesting that males and females could be found there together. The spiders were identified as an undescribed species of *Patu*, having the characters diagnostic for that genus (Forster and Platnick 1977:15): chelicerae fused only near the base, an elevated pars cephalica and six eyes in three diads. The male and female genitalia are unlike those of any described species.

Eggsacs were found attached to frame lines on the periphery of the webs of six adult females (Figs. 1, 3), always on that side of the web nearest the surface of an embankment, log or tree trunk. If eggsacs were present the female hung close to them. Females without eggsacs hung from the hub at the center of the web. The eggsacs were attached to the web by one or a few silken lines and were separate (Fig. 4) or contiguous (Fig. 2). In some cases bits of moss, wood (Fig. 5) or other

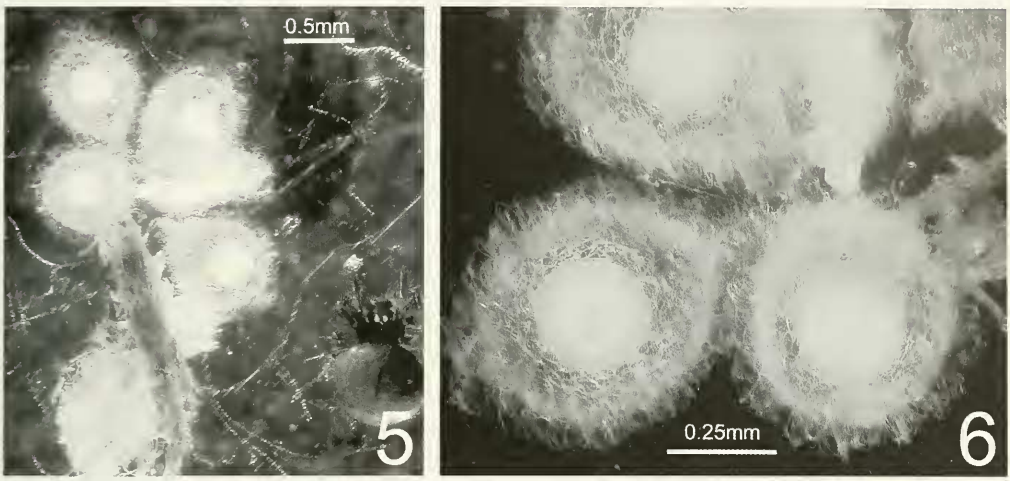


FIGURES 1–4. Webs and eggsacs of *Patu* sp. from QiQi, Gaoligongshan, China. Webs and eggsacs have been dusted with corn starch to enhance their visibility. 1. Completed web: arrow to eggsacs at top of photo (Voucher CASENT 9000342). 2. Close up of eggsac group on frame at periphery of web (Voucher CASENT 9000342). 3. Incomplete web with temporary spiral: arrow to eggsac at upper right of photo (Voucher CASENT 9000340). 4. Close up of eggsac group on frame at periphery of web (Voucher CASENT 9000340). Photos 1 and 2 by L. Dong, 3 and 4 by C. Griswold.

debris were attached to one or more of the eggsacs, but in all cases the eggsacs were clearly exposed. There was no attempt to camouflage the eggsacs. The number of eggsacs per group ranged from four to eleven ($\bar{X} = 7$, N = 6). The eggsacs were about the same size as the female that made them (Fig. 5): females ranged from 0.74 to 0.96 mm in total length, whereas the eggsacs ranged from 0.64 to 1.00mm in diameter (N eggsacs measured = 35, X diameter = 0.82mm). Eggsacs contained either a single egg or developing embryo and all were translucent but rendered conspicuous even in their low light habitats by the single bright white egg or embryo within each one. Each eggsac consisted of a sphere of fine silk woven loosely and covered with loops of silk projecting from the surface (Fig. 6). This is exactly the form described by Marples (1951:51) for the "cocoons" of *P. samoensis*.

DISCUSSION

The eggsac placement discovered in this new Chinese species of *Patu* is identical to that found by Marples fifty years earlier for *Patu* species from Samoa and Fiji. The only other symphytog-



FIGURES 5–6. Eggsacs of *Patu* sp. from QiQi, Gaoligongshan, China, preserved specimens. 5. Five eggsacs with female at lower right (Voucher CASENT 9000340). 6. Close up of eggsacs (Voucher CASENT 9000340).

nathid for which the eggsac is known, *Symphytognatha globosa* Hickman from Tasmania, makes a strikingly different, densely woven, triangular eggsac studded with sharp silken points (Hickman 1931, Plate I, fig. 3). The uniformity of eggsacs within *Patu* and their difference from *Symphytognatha* suggest that eggsac form may be an informative character within the Symphytognathidae.

Griswold, Coddington, Hormiga and Scharff (1998) placed the Symphytognathidae in the "Symphytognathoids", which comprised the Anapidae, Mysmenidae, Symphytognathidae and Theridiosomatidae and were characterized by the unambiguous synapomorphies of posteriorly truncate sternum, loss of the claw on the female palp, greatly elongate fourth tarsal median claw, and double attachment of the eggsac near the hub. Schütt (2003) considered the same taxa, with the addition of the Microphocommatidae, as Symphytognathidae *sensu lato*. In neither of those papers, nor in an earlier quantitative treatment of araneoid phylogeny (Coddington 1990), was symphytognathid eggsac attachment behavior scored for this family because Marples' field observation was overlooked and Hickman's lab observations were considered possibly artifactual. Character 91 in Griswold et al. (1998) was "Eggsac doubly attached: (0) absent; (1) present". The authors noted that "basal theridiosomatid genera such as *Ogulnius, Plato, Naatlo, Epeirotypus*, the anapids *Anapis, Anapisona*, and the mysmenids *Mysmena* and *Maymena* retain their eggsacs at or near the hub of their webs . . . attached by two silk lines within the web or with one line attaching to the substrate" (Griswold et al. 1998:45). This behavior should be more precisely defined as eggsac doubly attached during construction, because whereas some taxa leave the eggsac doubly attached others, e.g., distal theridiosomatids (some *Plato*), cut the bottom attachment so that the eggsac appears singly attached (J. Coddington, pers. commun.). The previous second attachment may be visible as a nubbin on the eggsac. The results of the analysis of Griswold et al. (1998) implied such behavior for the Symphytognathidae. It is uncertain if this is the case for this species of *Patu*, but at least the upper eggsac in Figure 5 has a small nubbin on the rounder end that may be the vestige of a former double attachment.

Other questions remain. Although numerous *Patu* have been observed on several continents, eggsacs have been observed only for the Samoan and Fijian species (Marples 1951) and this Chinese species. Why should this behavior be so rarely observed? The haphazard arrangement of the eggsacs on the frame of the web suggests that they may have been transported there after con-

struction. Perhaps other *Patu* species transport the eggsacs farther, where they are overlooked.

Behavioral characters will undoubtedly help to clarify the evolution of these minute spiders. We hope that Arachnologists, armed with corn starch, spoons, patience and good eyesight, will add to our growing store of observations of these cryptic but fascinating animals.

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Literature cited

Baert, L., and R. Jocqué. 1993. *Anapistula caecula* n. sp., the smallest known female spider (Araneae, Symphytognathidae). *Journal of African Zoology* 107:187–189.

Coddington, J.A. 1986. The monophyletic origin of the orb web. Pages 319–363 *in*. W.A. Shear, ed., *Spiders: Webs, Behavior, and Evolution*. Stanford University Press, Stanford, California.

Coddington, J.A. 1990. Ontogeny and homology in the male palpus of orb-weaving spiders and their relatives, with comments on phylogeny (Araneoclada: Araneoidea, Deinopoidea). *Smithsonian Contributions to Zoology* 496:1–52.

Eberhard, W.G. 1987. Web-building behavior of anapid, symphytognathid, and mysmenid spiders (Araneae). *Journal of Arachnology* 14(3):339–356.

Forster, R.R. 1959. The spiders of the family Symphytognathidae. *Transactions of the Royal Society of New Zealand* 86:269–329

Forster, R.R., and N.I. Platnick. 1977. A review of the spider family Symphytognathidae (Arachnida, Araneae). *American Museum Novitates* 2619:1–29.

Griswold, C.E., J.A. Coddington, G. Hormiga, and N. Scharff. 1998. Phylogeny of the orb-web building spiders (Araneae, Orbiculariae: Deinopoidea, Araneoidea). *Zoological Journal of the Linnean Society* 123: 1–99.

Griswold, C.E., C.L. Long, and G. Hormiga. 1999. A new spider of the genus *Pimoa* from Gaoligong Mountains, Yunnan, China (Araneae, Araneoidea, Pimoidae). *Acta Botanica Yunnanica* 1999, suppl XI: 91–97, plates I–V.

Hickman, V.V. 1931. A new family of spiders. *Proceedings of the Zoological Society of London* (B) 1931: 1321–1328.

Hiramatsu, T., and A. Shinkai. 1993. Web structure and web-building behavior of *Patu* sp. (Araneae: Symphytognathidae). *Acta-Arachnologica* 42(2):181–185

Marples, B.J. 1951. Pacific symphytognathid spiders. *Pacific Science* 5:47–51.

Myers, N. 1988. Threatened Biotas: "Hotspots" in tropical forest. *The Environmentalist* 8(3):1–20.

Schütt, K. 2003. Phylogeny of the Symphytognathidae s.l. (Araneae, Araneoidea). *Zoologica Scripta* 32(2):129–152.